THEREFORE, WE CLAIM:

1. A coating composition formed from components comprising:

(a) at least one first material comprising at least one radiation curable reactive functional group;

(b) at least one second material comprising at least one thermally curable reactive functional group;

(c) at least one curing agent reactive with the at least one thermally curable reactive functional group, the at least one curing agent being selected from aminoplast resins, polyisocyanates, blocked polyisocyanates, triazine derived isocyanates, polyepoxides, polyacids, polyols and mixtures of the foregoing; and

(d) a plurality of particles selected from inorganic particles, composite particles, and mixtures of the foregoing,

wherein each component is different.

2. A coating composition according to claim 1, wherein the at least one radiation curable reactive functional group is selected from vinyl groups, vinyl ether groups, unsaturated ester groups, epoxy groups, maleimide groups, and fumarate groups.

3. A coating composition according to claim 2, wherein the at least one radiation curable reactive functional group is an unsaturated ester group selected from acrylate groups, methacrylate groups, and ethacrylate groups.

4. A coating composition according to claim 3, wherein the unsaturated ester group is an acrylate group.

5. A coating composition according to claim 1, wherein the first material comprises polysiloxane.

6. A coating composition according to claim 1, wherein the first material, when added to other components that form the coating composition, is present in the coating composition in an amount ranging from 1 to 99 weight percent based on total weight of the resin solids of the components which form the coating composition

7. A coating composition according to claim 1, wherein the at least one radiation curable reactive functional group is curable by ionizing radiation.

8. A coating composition according to claim 1, wherein the at least one radiation curable reactive functional group is curable by actinic radiation.

9. A coating composition according to claim 1, wherein the at least one radiation curable reactive functional group is curable by ultraviolet radiation.

10. A coating composition according to claim 1, wherein the at least one thermally curable reactive functional group is selected from the group consisting of hydroxyl groups, vinyl groups, urethane groups, urea groups, amide groups, carbamate groups, isocyanate groups, blocked isocyanate groups, epoxy groups, carbonyl groups, amine groups, anhydride groups, hydroxyalkyl amide groups, and aziridine groups.

11. A coating composition according to claim 1, wherein the second material is a film-forming polymer selected from the group consisting of hydroxyl functional polymers, polyesters, acrylic polymers, polyurethanes, polyureas, polyamides, carbamate functional polymers, polyisocyanates different from curing agent (c), blocked polyisocyanates different from curing agent (c), polyepoxides different from curing agent (c), polyethers, polyacids different from curing agent (c), polyamines, polyanhydrides and copolymers and mixtures of the foregoing.

12. A coating composition according to claim 11, wherein the second material comprises at least one polysiloxane.

13. A coating composition according to claim 12, wherein the at least one polysiloxane comprises at least one of the following structural units (I) :

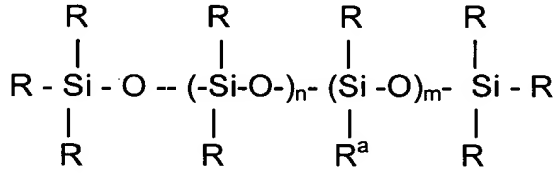
(I) $R^1_nR^2_mSiO_{(4-n-m)/2}$

wherein each R^1, which may be identical or different, represents H, OH, a monovalent hydrocarbon group or a monovalent siloxane group; each R^2, which may be identical or different, represents a group comprising at least one reactive functional group, wherein m and n each represents a number fulfilling the requirements of $0<n<4$, $0<m<4$ and $2\leq(m+n)<4$.

14. A coating composition according to claim 13, wherein each R^2, which may be identical or different, represents a group comprising at least one reactive functional group selected from a hydroxyl group, a carboxyl group, an isocyanate group, a blocked polyisocyanate group, a primary amine group, a secondary amine group, an amide group, a carbamate group, a urea group, a urethane group, a vinyl group, an unsaturated ester group, a maleimide group, a fumarate group, an anhydride group, a hydroxy alkylamide group, and an epoxy group.

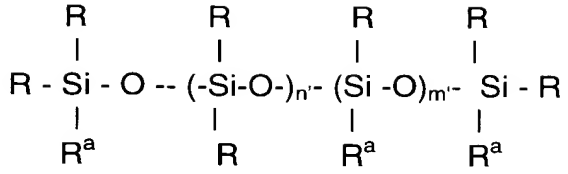
15. A composition according to claim 12, wherein the at least one polysiloxane has the following structure (II) or (III):

(II)



or

(III)



wherein:

m has a value of at least 1;

m' ranges from 0 to 75;

n ranges from 0 to 75;

n' ranges from 0 to 75;

each R, which may be identical or different, is selected from H, OH, monovalent hydrocarbon groups, monovalent siloxane groups, and mixtures of any of the foregoing; and

$-R^a$ comprises the following structure (IV):

(IV) $-R^3-X$

wherein $-R^3$ is selected from an alkylene group, an oxyalkylene group, an alkylene aryl group, an alkenylene group, an oxyalkenylene group, and an alkenylene aryl group; and

X represents a group which comprises at least one reactive functional group selected from a hydroxyl group, a carboxyl group, an isocyanate group, a blocked polyisocyanate group, a primary amine group, a secondary amine group, an amide group, a carbamate group, a urea group, a urethane group, a vinyl group, an unsaturated ester group, a maleimide group, a fumarate group, an anhydride group, a hydroxy alkylamide group, and an epoxy group.

16. A coating composition according to claim 12, wherein the at least one polysiloxane is present in an amount of 0.5 to 75 weight percent on a basis of total weight of the resin solids of the components which form the coating composition.

17. A coating composition according to claim 1, wherein the second material, when added to other components that form the coating composition, is present in the coating composition in an amount ranging from 0.5 to 98.5 weight percent based on total weight of the resin solids of the components which form the coating composition.

18. A coating composition according to claim 1, wherein the curing agent is selected from an aminoplast resin, a polyisocyanate and a blocked polyisocyanate.

19. A coating composition according to claim 18, wherein the curing agent is a polyisocyanate.

20. A coating composition according to claim 1, wherein the curing agent, when added to other components that form the coating composition, is present in the coating composition in an amount ranging from 0.5 to 65 weight percent based on total weight of the resin solids of the components which form the coating composition.

21. A coating composition according to claim 1, wherein the particles are selected from fumed silica, amorphous silica, colloidal silica, alumina, colloidal alumina, titanium dioxide, cesium oxide, yttrium oxide, colloidal yttria, zirconia, colloidal zirconia and mixtures of any of the foregoing.

22. A coating composition according to claim 1, wherein the particles are surface treated.

23. A coating composition according to claim 21, wherein the particles include colloidal silica.

24. A coating composition according to claim 1, wherein the particles have an average particle size of less than 100 micrometers prior to incorporation into the composition.

25. A coating composition according to claim 24, wherein the particles have an average particle size of less than 50 micrometers prior to incorporation into the composition.

26. A coating composition according to claim 1, wherein the particles have an average particle size ranging from 1 to less than 1000 nanometers prior to incorporation into the composition.

27. A coating composition according to claim 26, wherein the particles have an average particle size ranging from 1 to 100 nanometers prior to incorporation into the composition.

28. A coating composition according to claim 27, wherein the particles have an average particle size ranging from 5 to 50 nanometers prior to incorporation into the composition.

29. A coating composition according to claim 1, wherein the particles, when added to the other components that form the composition, are present in the composition in an amount ranging from 0.01 to 75 weight percent based on total weight of the resin solids of the components which form the composition.

30. A coating composition according to claim 29, wherein the particles are present in an amount of at least 0.1 weight percent.

31. A coating composition according to claim 30, wherein the particles are present in an amount of at least 0.5 weight percent.

32. A coating composition according to claim 31, wherein the particles are present in an amount of at least 5 weight percent.

33. A coating composition according to claim 1, wherein the components which form the composition comprise at least one surface active agent.

34. A coating composition according to claim 33, wherein the at least one surface active agent is selected from an anionic surface active agent, a nonionic surface active agent and a cationic surface active agent.

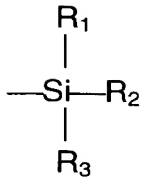
35. A coating composition according to claim 1, wherein the components which form the composition comprise at least one photoinitiator.

36. A coating composition according to claim 35, wherein the at least one photoinitiator is selected from benzoin, benzophenone, hydroxy benzophenone, anthraquinone, thioxanthone, substituted benzoins such as butyl isomers of benzoin ethers, α,α-diethoxyacetophenone, α,α-dimethoxy-α-phenylacetophenone, 2-hydroxy-2-methyl-1-phenyl propane 1-one, 2,4,6-trimethyl benzoyl diphenyl phosphine oxide, and mixtures of the foregoing.

37. A coating composition according to claim 35, wherein the at least one photoinitiator is a 50:50 blend of 2-hydroxy-2-methyl-1-phenyl propan-1-one and 2,4,6-trimethyl benzoyl diphenyl phosphine oxide.

38. A coating composition according to claim 1, wherein the components from which the composition is formed comprise at least one material which has at least one reactive functional group which is blocked with a silyl group.

39. A coating composition according to claim 38, wherein the silyl blocking group has the following structure (IX):

(IX) 

wherein each R_1, R_2 and R_3, which may be identical or different, represents an alkyl group having from 1 to 18 carbon atoms, a phenyl group or an allyl group.

40. A coating composition according to claim 1, wherein the composition when cured has an initial scratch resistance value such that after scratch testing greater than 40 percent of the initial 20° gloss is retained.

41. A coating composition according to claim 1, wherein the composition when cured has a retained scratch resistance value such that after scratch testing greater than 30 percent of the initial 20° gloss is retained.

42. A cured coating formed from the composition of claim 1.

43. A cured composition according to claim 42, wherein the cured composition is cured by exposure to (1) ionizing radiation or actinic radiation and (2) thermal energy.

44. A cured composition according to claim 42, wherein the cured composition is cured by exposure to (1) ultraviolet radiation and (2) thermal energy.

45. A coated substrate comprising a substrate and a composition according to claim 1 deposited over at least a portion of the substrate.

46. A method for forming a cured coating on a substrate comprising applying over at least a portion of the substrate a coating composition according to claim 1.

47. A method according to claim 46, comprising the step of exposing the coating composition to (1) ionizing radiation or actinic radiation and (2) thermal energy.

48. A method according to claim 46, wherein the substrate is an automotive substrate.

49. A coated automobile substrate comprising an automobile substrate and a composition according to claim 1 deposited over at least a portion of the automobile substrate.

50. A coated automobile substrate according to claim 49, wherein the automobile substrate is a bumper.

51. A coated automobile substrate according to claim 49, wherein the automobile substrate is a hood.

52. A coated automobile substrate according to claim 49, wherein the automobile substrate is a door.

53. A coated automobile substrate according to claim 49, wherein the automobile substrate is a fender.

54. A multi-component composite coating composition comprising a basecoat deposited from a pigmented coating composition, and a composition according to claim 1 applied over at least a portion of the basecoat.

55. A multi-component composite according to claim 54, wherein the composition is a topcoat.

56. A multi-component composite according to claim 55, wherein the composition is transparent when cured.

57. A method for making a multi-component composite comprising:

(a) applying a pigmented coating composition to a substrate to form a basecoat;

(b) applying a coating composition according to claim 1 as a topcoating composition over at least a portion of the basecoat; and

(c) curing the coating composition to form a cured coating.

58. A method according to claim 57, wherein the topcoating composition is cured by exposure to (1) ionizing radiation or actinic radiation and (2) thermal energy after application to the substrate.

59. A method for improving the scratch resistance of a polymeric substrate or polymer coated substrate comprising forming a composition according to claim 1 over at least a portion of the substrate.

60. A method for retaining the gloss of a polymeric substrate or polymer coated substrate over a predetermined period of time comprising forming a composition according to claim 1 over the surface of the substrate.

61. A method for revitalizing the gloss of a polymeric substrate or polymer coated substrate comprising forming a composition according to claim 1 over the surface of the substrate.

62. A coating composition formed from components comprising:

(a) a first material comprising at least one radiation curable reactive functional group;

(b) a second material comprising at least one thermally curable reactive functional group;

(c) at least one curing agent reactive with the at least one thermally curable reactive functional group, the at least one curing agent being selected from aminoplast resins, polyisocyanates, blocked polyisocyanates, triazine derived isocyanates, polyepoxides, polyacids, polyols and mixtures of the foregoing; and

(d) a plurality of particles,

wherein each component is different.

63. A composition according to claim 62, wherein the composition when cured has an initial scratch resistance value such that after scratch testing greater than 40 percent of the initial 20° gloss is retained.

64. A composition according to claim 62, wherein the composition when cured has a retained scratch resistance value such that after scratch testing greater than 30 percent of the initial 20° gloss is retained.

65. A cured coating formed from the composition of claim 62.

66. A coated substrate comprising a substrate and a composition according to claim 62 deposited over at least a portion of the substrate.

67. A method for forming a cured coating on a substrate comprising applying over at least a portion of the substrate a coating composition according to claim 62.

68. A method according to claim 67, wherein the coating composition is cured by exposing the coating composition to (1) actinic or ionizing radiation and (2) thermal energy after application to the substrate.

69. A method according to claim 67, wherein the substrate is an automotive substrate.

70. A coated automobile substrate comprising an automobile substrate and a composition according to claim 62 deposited over at least a portion of the automobile substrate.

71. A multi-component composite coating composition comprising a basecoat deposited from a pigmented coating composition, and a composition according to claim 62 applied over at least a portion of the basecoat.

72. A method for making a multi-component composite comprising:

(a) applying a pigmented composition to a substrate to form a basecoat;

(b) applying a coating composition according to claim 62 as a topcoating composition over at least a portion of the basecoat; and

(c) curing the coating composition to form a cured coating.

73. A method for improving the scratch resistance of a polymeric substrate or polymer coated substrate comprising forming a composition according to claim 62 over at least a portion of the substrate.

74. A method for retaining the gloss of a polymeric substrate or polymer coated substrate over a predetermined period of time comprising forming a composition according to claim 62 over the surface of the substrate.

75. A method for revitalizing the gloss of a polymeric substrate or polymer coated substrate comprising forming a composition according to claim 62 over the surface of the substrate.

76. A coating composition formed from components comprising:

(a) at least one material comprising at least one ultraviolet radiation curable reactive functional group and at least one thermally curable reactive functional group;

(b) at least one curing agent reactive with the at least one thermally curable reactive functional group, the at least one curing agent being selected from polyisocyanates, blocked polyisocyanates, triazine derived isocyanates, polyepoxides, polyacids, polyols and mixtures of the foregoing; and

(c) a plurality of particles,

wherein each component is different.

77. A composition according to claim 76, wherein the composition when cured has an initial scratch resistance value such that after scratch testing greater than 40 percent of the initial 20° gloss is retained.

78. A composition according to claim 76, wherein the composition when cured has a retained scratch resistance value such that after scratch testing greater than 30 percent of the initial 20° gloss is retained.

79. A cured coating formed from the composition of claim 76.

80. A coated substrate comprising a substrate and a composition according to claim 76 deposited over at least a portion of the substrate.

81. A method for forming a cured composition on a substrate comprising applying over at least a portion of the substrate a coating composition according to claim 76 and curing the coating composition after application to the substrate.

82. A coated automobile substrate comprising an automobile substrate and a composition according to claim 76 deposited over at least a portion of the automobile substrate.

83. A multi-component composite coating composition comprising a basecoat deposited from a pigmented coating composition, and a composition according to claim 76 applied over at least a portion of the basecoat.

84. A method for making a multi-component composite comprising:

(a) applying a pigmented composition to a substrate to form a basecoat;

(b) applying a coating composition according to claim 76 as a topcoating composition over at least a portion of the basecoat; and

(c) curing the coating composition to form a cured coating.

85. A method for improving the scratch resistance of a polymeric substrate or polymer coated substrate comprising forming a composition according to claim 76 over at least a portion of the substrate.

86. A method for retaining the gloss of a polymeric substrate or polymer coated substrate over a predetermined period of time comprising forming a composition according to claim 76 over the surface of the substrate.

87. A method for revitalizing the gloss of a polymeric substrate or polymer coated substrate comprising forming a composition according to claim 76 over the surface of the substrate.